Green Aviation – A Paradigm shift from Quantitative to Qualitative Growth

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Greener Skies Ahead
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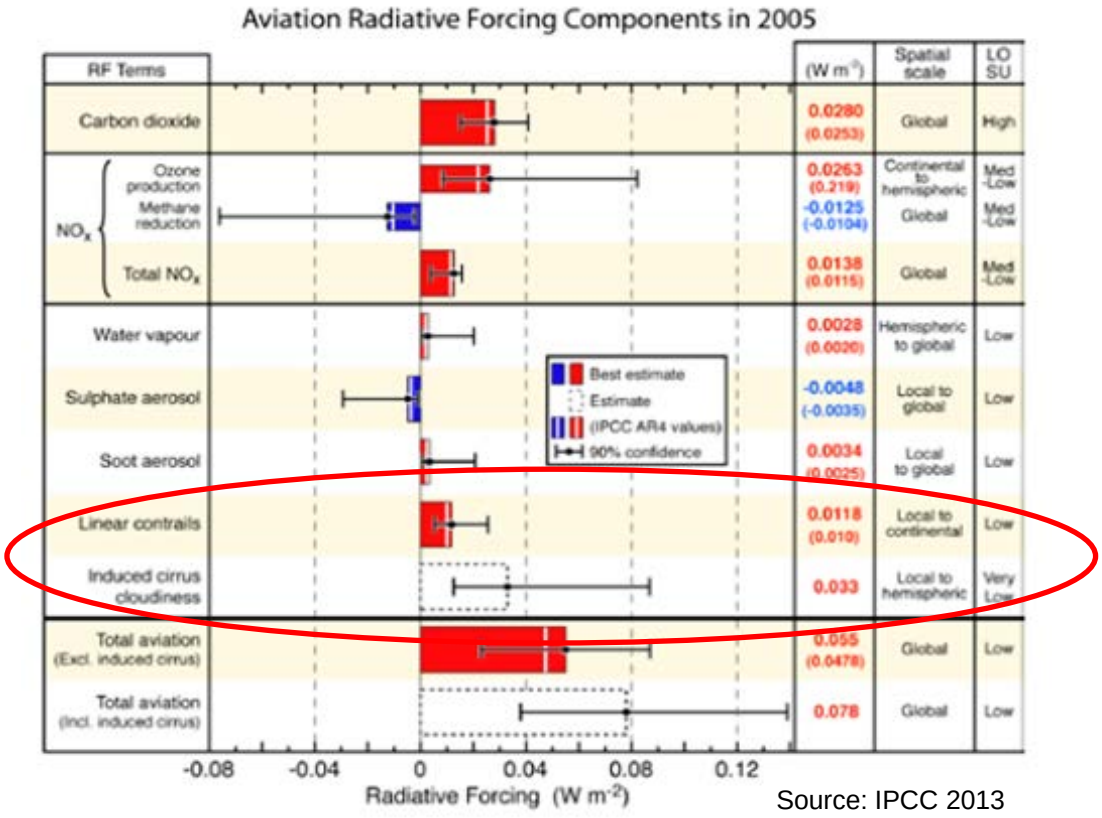
Outline

- Next 30 Years in Aviation
- Aircraft Technologies from Operational Perspective
  - Laminar Flow Technology
  - Change Operational Flight Profiles
  - Modifications in Weight and Fuel
- Summary

Next 30 Years in Aviation

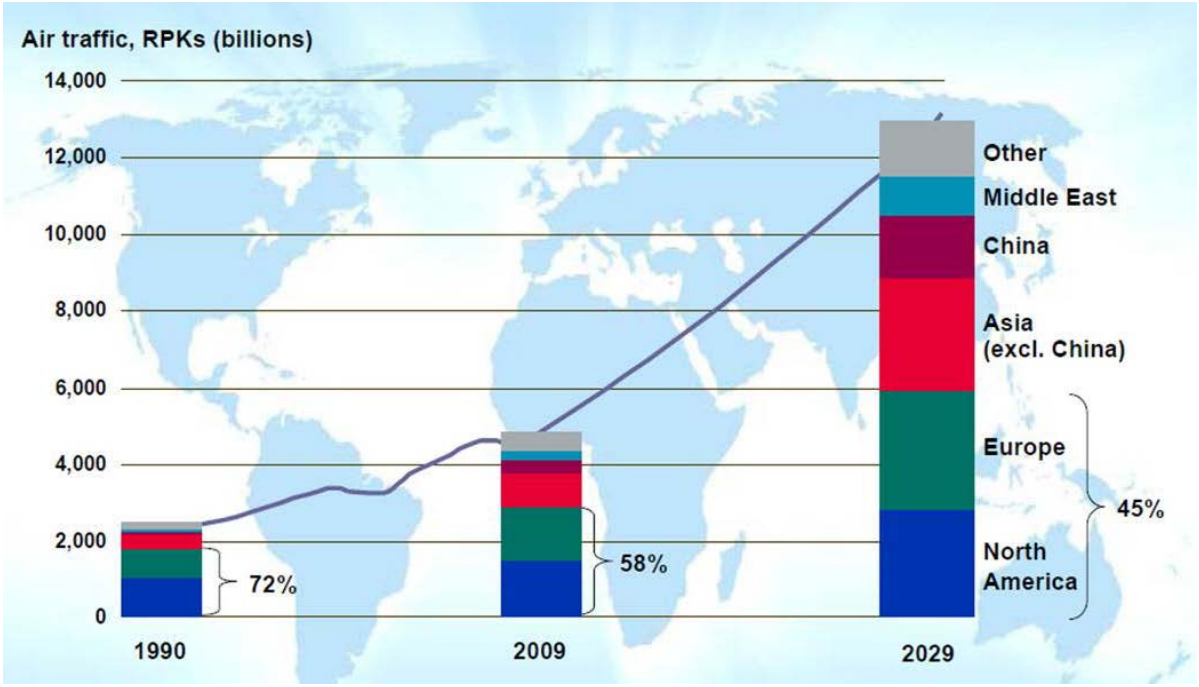


Source: IPCC 2013

Aviation induced contrails become a major issue of climate impact

Aviation operations are more relevant!

Next 30 Years in Aviation

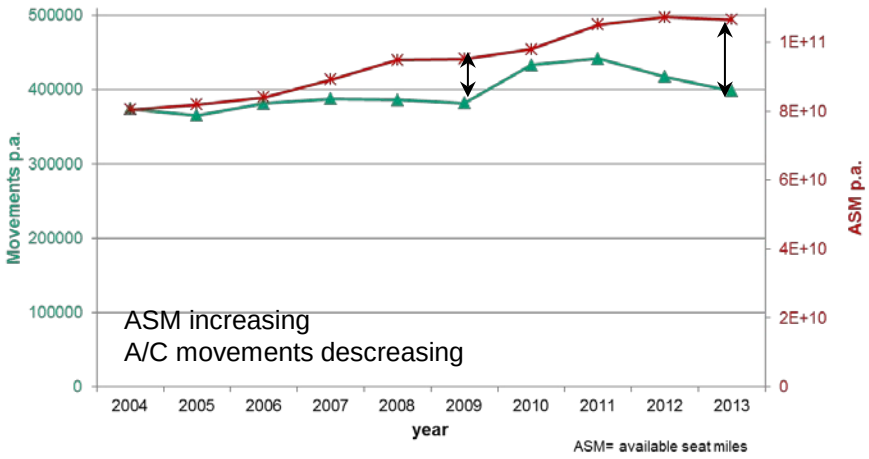


Roger Pielke, University of Colorado at Boulder

Envisaged **growth** of aviation of about **5%** is related to increasing **passenger movements**

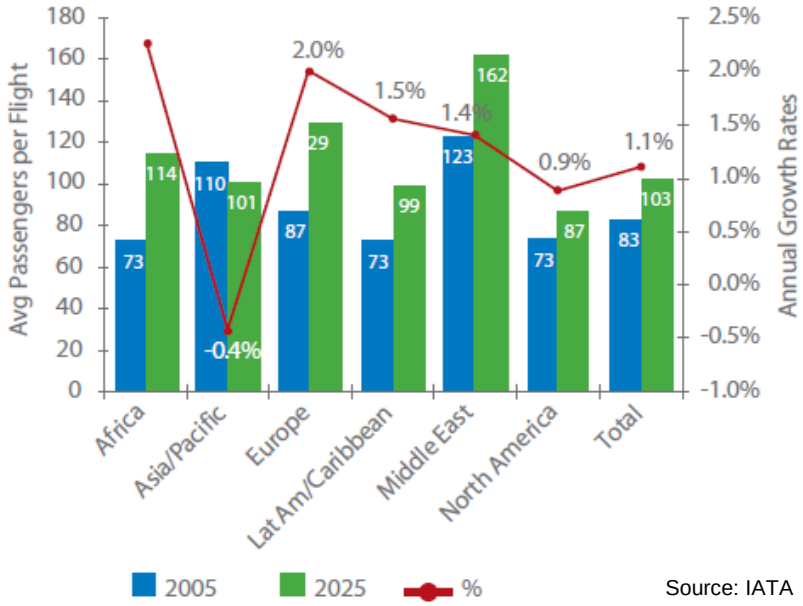
Next 30 Years in Aviation

A/C movements vs. available seat miles at Lufthansa



Source: Source Institute for Air Transportation Systems, DLR

Development of passenger per flight

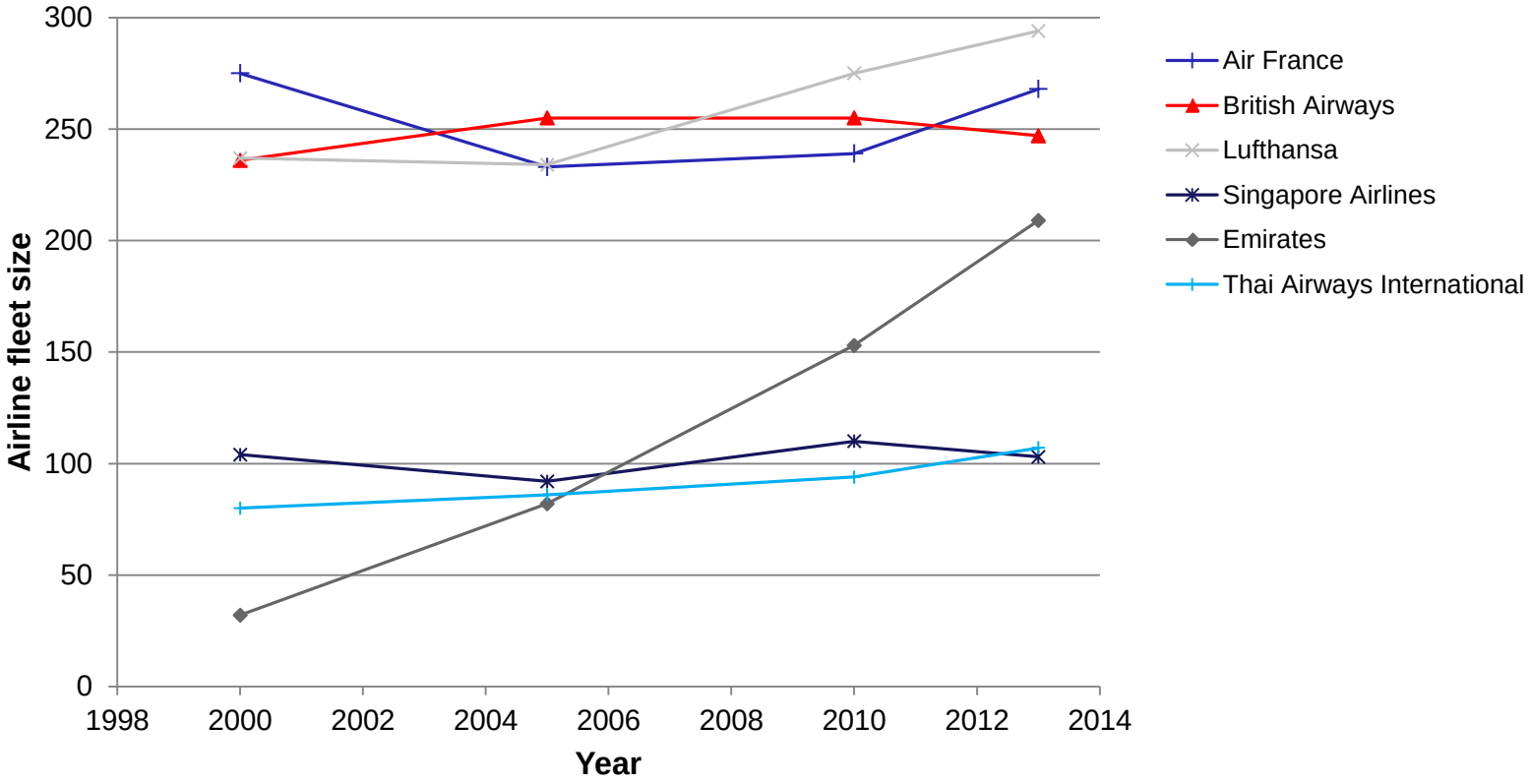


Source: IATA

Trend towards larger aircraft and more passenger per flight

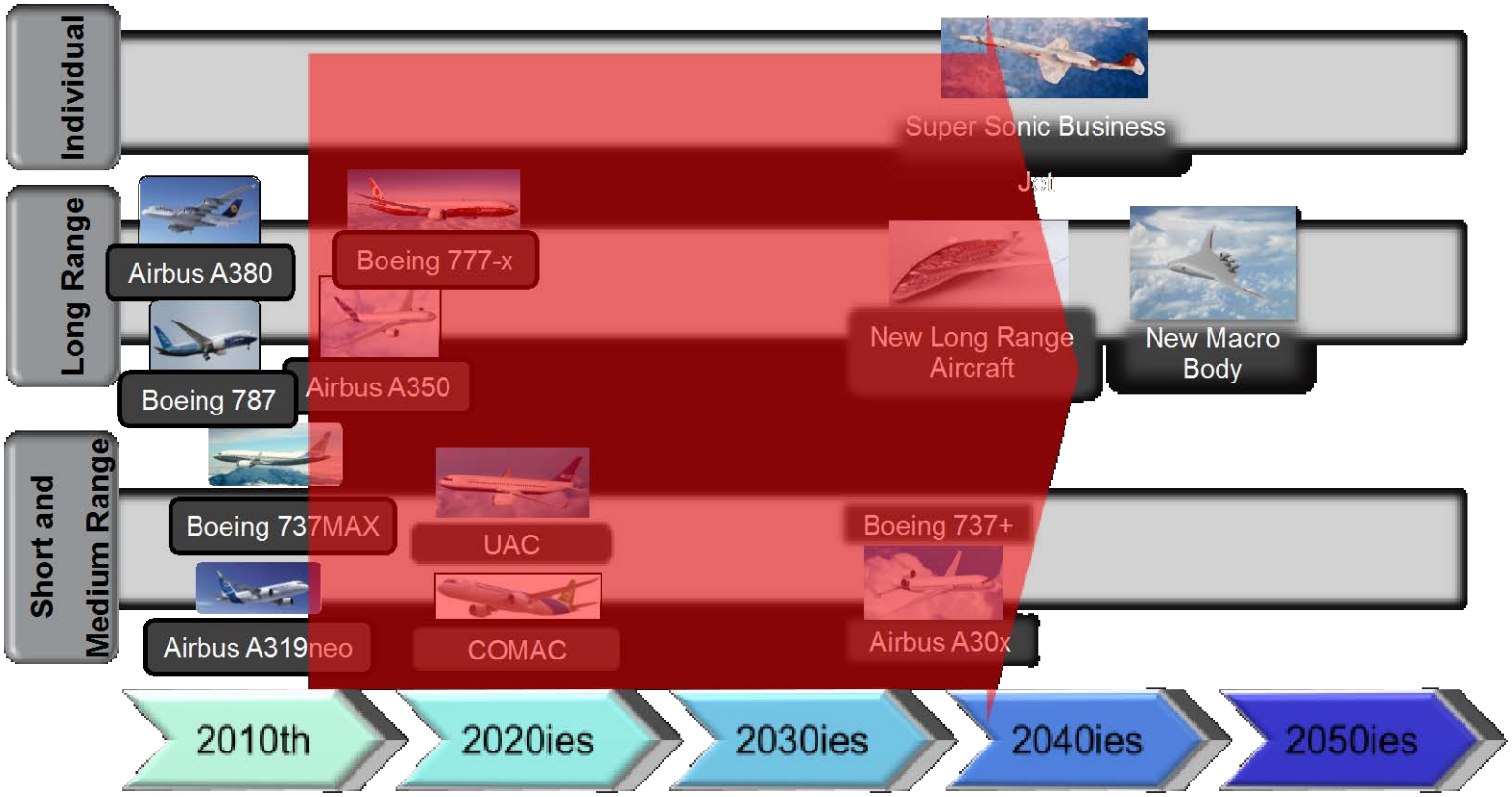
Better climate and transport efficiency

Next 30 Years in Aviation



Airlines tend to operate nearly constant fleets with increasing seat capacity except Asian airlines

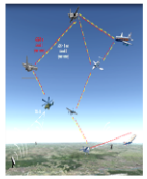
Next 30 Years in Aviation



All Aircraft of the next 25 years are fixed and known

Next 30 Years in Aviation

Business Driver in Aviation

Stakeholder	Revenue Source	
 Airline	**Passenger**	
 Airport	**Passenger**	
	Airline **fees**	
 Air Navigation Services	Airline **fees**	
BOEING BOMBARDIER the evolution of mobility AIRBUS EMBRAER COMAC Aircraft Manufacturer	Aircraft **sale**	

Passenger and fees drive revenue for all system stakeholder

Energy, staff cost most relevant for all system stakeholder

Next 30 Years in Aviation

- People´s **mobility does not** neccessarily **require more aircraft**
- **Contrails** seem to be as **relevant** as CO_2 emissions **for Green Aviation**
- **Energy cost** will drive the business
- **No window of opportunity** for aircraft configuration technologies **until 2035**
- **After sales services** become an interesting market
- **Product life cycle improvements**
  - New cabin interiors
  - Software updates and upgrades
  - Minor modifications
  - Maintenance Repair Overhaul
- **Operational Improvements** crucial for sustainable Green Aviation

Make money with qualitative improvements during life cycle of a constant and existing fleet and more passenger

Paradigm shift from quantitative air transport growth **to qualitative air transport growth**

Aircraft Technologies from Operational Perspective

Aircraft Technologies from Operational Perspective

Laminar Flow Technology

1 Questions of Interest

- **Is there a real benefit for operators?**
  - Realistic operational scenarios
  - Fuel saving on aircraft and fleet level
  - Economic effects
  - Operational boundary conditions

2 Tool Chain

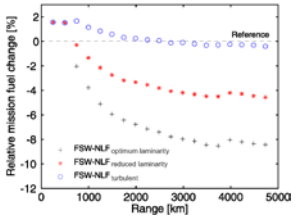
- **Single flight analysis**
  - Reference aircraft
- **Real route analysis**
  - Real airline network and frequencies
- **Network model and analysis**
  - Simulation of reference and LamAiR aircraft in a generic realistic airline network
- **Economic analysis**
  - Airline Life Cycle Cost analysis
  - Variation of : MRO cost, A/C price, fuel price, leg length

3 Results

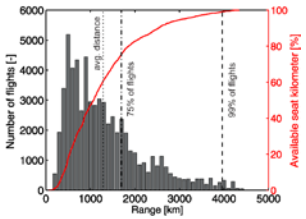
- Break-even mission range
- Fuel savings on fleet level
- Break-even fuel price

Aircraft Technologies from Operational Perspective

Laminar Flow Technology



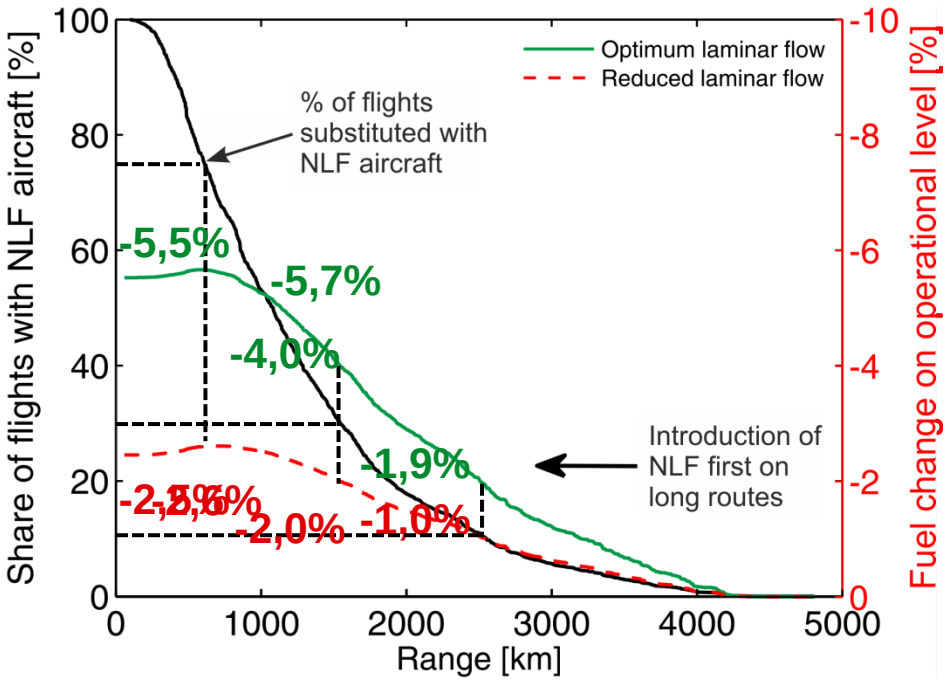
Theoretical potential of nearly 8% on aircraft level



75% of all short range flights below 2000 km

Analysis performed on real airline network

Fuel saving from operational perspective



On real airline fleet level **fuel savings less than** those by **wing lets**

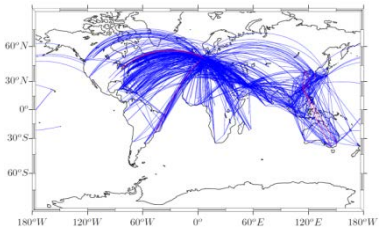
Net Present Value decreasing

Aircraft Technologies from Operational Perspective

Change operational flight profils

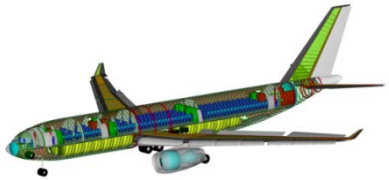
Identification of **reduced climate** impact by

- ➢lower flight altitudes and
- ➢reduced cruise speeds



World fleet of a represeantative **long range aircraft**

Real flight trajectories used as reference for assessment



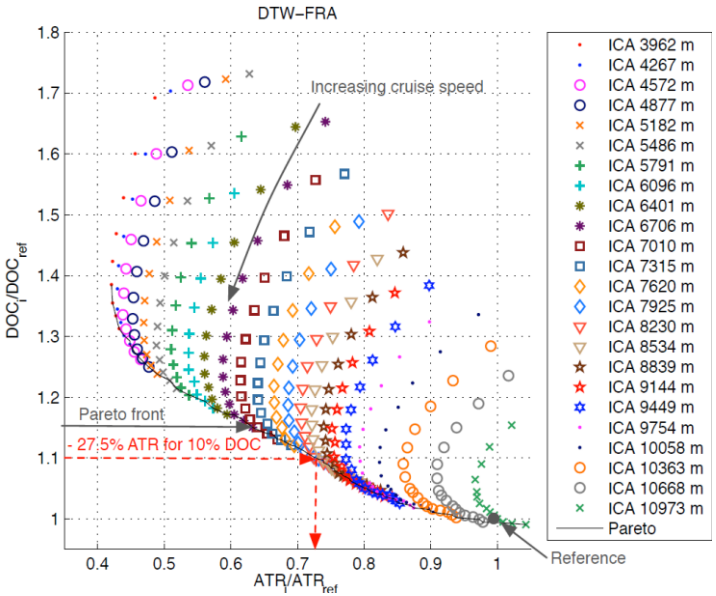
Average Temperature Response (ATR) and **Direct Operating Costs** (DOC) used as metrices

Cost-Benefit-Assessment of ATR and DOC change relatively to actual flight profiles

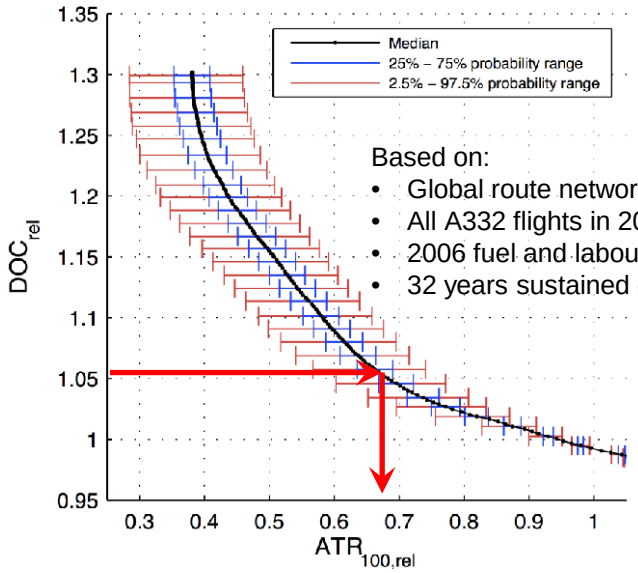
Aircraft Technologies from Operational Perspective

Change operational flight profils

Reduced climate impact through lower flight profiles



Climate impact of global A330-200 fleet



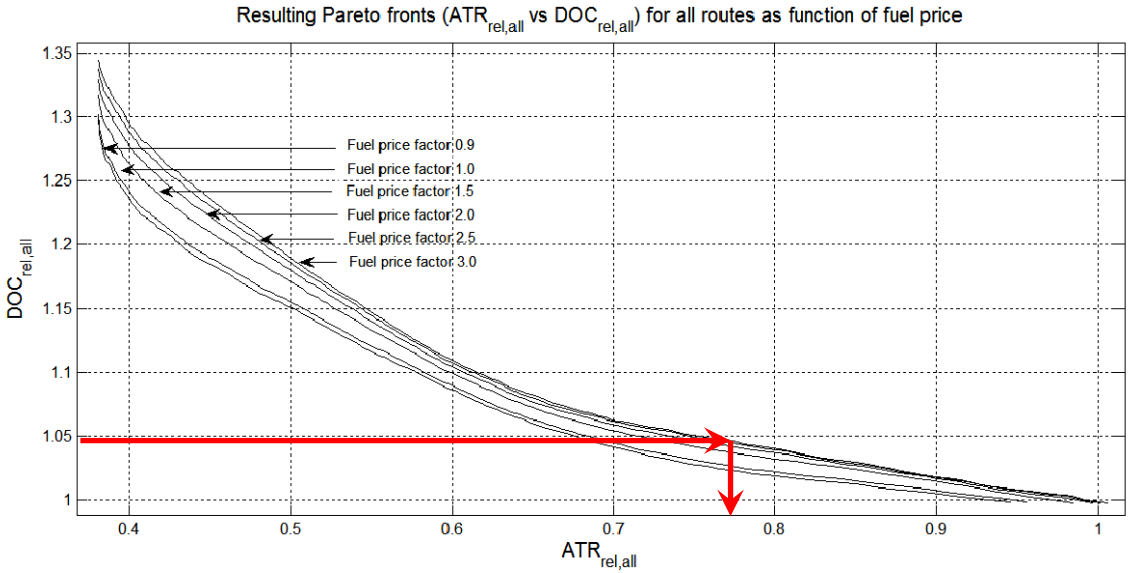
Based on:
- Global route network
- All A332 flights in 2006
- 2006 fuel and labour price levels
- 32 years sustained emission

5% DOC increase due to higher fuel consumption with less climate impact results in **31% temperature raise damping**!

A. Koch, et.Al., Climate impact assessment of varying cruise flight altitudes applying the CATS simulation approach, 3rd International Conference of the European Aerospace Societies, (CEAS), Venice, Italy (2011).

Aircraft Technologies from Operational Perspective

Change operational flight profils



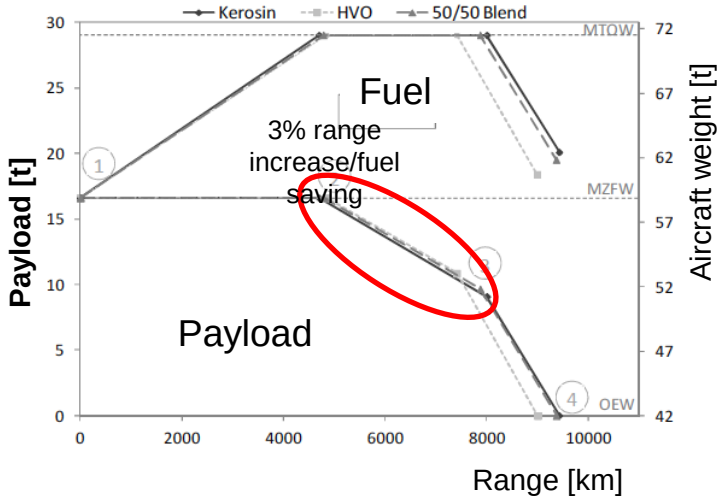
22% temperature raise damping remain at 300% fuel price raise

Cruise speed selection depends on **constant utilization**

ATR reduction only possible if **no additional aircraft** movements, **but larger aircraft** possible

Aircraft Technologies from Operational Perspective

Modifications in weight and fuel



Light weight and compact seats: increase capacity (+12/150) and reduce weight (-30%/seat)
Resulting in 130.000kg fuel saving per year and aircraft

Use of Hydrotreated Vegetable Oil (HVO) leads to
1,87% (50/50) - 3% (100%) fuel savings at max payload, which is closer to real operations than max. range flights

-SITA Airline IT trends 2008

Summary

- **Contrails** become as **relevant** as CO_2 for aviation climate impact
- **No** potential for **new** green **aircraft** until 2035
- **Laminar** technology **no option** from operational point of view
- **In service technologies** allow for greener operations
  - Flying slower and lower
  - Reduce cabin weight
- **Bigger aircraft** improve climate efficiency

Improve quality instead increasing quantity!

DLR Hamburg

TUHH Technische Universität Hamburg-Harburg

Thanks for listening!

DLR

Location

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